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(54) **Sound insulating carpets**

(57) A carpet construction having superior sound insulating characteristics useful in the preparation of carpeting for covering the floor of an automobile is disclosed. A carpet has bonded to its rear surface a composition comprising a polyolefin, synthetic rubber, petroleum oil and an inorganic filler. The concentration of inorganic filler is sufficient to provide a composition having a density of at least 1.5 and, in combination with the disclosed polyolefin, synthetic rubber and oil, the flexural modulus of the composition does not exceed 5,000 kg/cm². Carpet constructions incorporating the composition are also disclosed including needle punched, looped-pile, and cut pile.

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SPECIFICATION

Sound insulating carpets (P–928)

This invention relates to a carpet having superior sound insulating characteristics, particularly for covering the floor of an automobile. This invention particularly relates to sound insulating carpeting which is highly flexible and readily formed by injection molding, extrusion and the like. More particularly the invention relates to carpet constructions, including a primary cloth with implanted carpet pile and a bonded, dense, sound insulating composition as a backing. Still more particularly this invention relates to methods for preparing sound insulating carpet constructions.

BACKGROUND OF THE INVENTION

It is known to cover the floor of an automobile with a carpet for shielding or absorbing any noise arising from the bottom of the automobile or its engine or the like to improve comfort when the automobile is running. A known carpet for covering the floor of an automobile is a carpet backed with a polyolefin resin such as polyethylene and an ethylene-vinyl acetate copolymer. The backing material has, however, had only a low surface density and failed to provide satisfactory sound insulation, since it contains no or little filler. In order to improve the sound insulation of such a carpet, it has been proposed to use a backing material containing a large quantity of a high-density filler.

The addition of a large quantity of a filler into a polyolefin results, however, in a sharp reduction in its melt-flow characteristics, and renders it difficult to mold in an injection molding machine, an extruder, or the like, since an extremely high torque is required. The backing material thus obtained forms a molded product having a poor appearance, and as it has a high flexural modulus, lacks flexibility and is brittle, and fails to adhere tightly to a carpet when used for backing it. Such material having a high flexural modulus is at a disadvantage in sound insulation, as its coincidence frequency falls within the audible range.

Among other polyolefins, an ethylene-vinyl acetate copolymer having a high vinyl acetate content is flammable, has a low melting point and is inferior in heat resistance even if it contains a large quantity of a filler.

SUMMARY OF THE INVENTION

This invention provides a sound insulating carpet which comprises a carpet having a rear surface, and a composition bonded to the rear surface of the carpet, comprising a polyolefin, synthetic rubber, petroleum oil and an inorganic filler, and having a density of at least 1.5 and a flexural modulus not exceeding 5,000 kg/cm^2. The carpet of this invention is superior in sound insulation and flexibility, and possesses the properties required of a carpet.

The sound insulating carpet construction of this invention may specifically be constructed in various forms, each comprising the composition described above, bonded to the rear surface of the carpet. In one embodiment a needle punched carpet is obtained by needle punching the carpet fibers on a primary cloth such as jute, synthetic fibers and flat yarn. In another embodiment, looped piles are implanted in the primary cloth and in still another embodiment cut piles are implanted in the primary cloth.

In a preferred embodiment the composition includes synthetic rubber from 5 to 400 parts by weight for 100 parts by weight of the polyolefin. In one embodiment, the synthetic rubber is preferably ethylene-α-olefin copolymer, such as ethylene-propylene rubber or ethylene-α-olefin terpolymer, such as ethylene-propylene-ethylidenenorbornene, ethylene-propylene-dicyclopentadiene or ethylene-propylene-1,4-hexadiene. In another preferred embodiment, the synthetic rubber comprises a copolymer of a monovinyl aromatic hydrocarbon and a conjugated diolefin, for example, styrene-butadiene rubber.

In another embodiment, the polyolefin component will be an α-olefin homopolymer such as polypropylene. In another embodiment the polyolefin is an ethylene-propylene block copolymer.

In yet another preferred embodiment the petroleum oil is a paraffinic process oil.

In another embodiment of this invention the composition includes inorganic filler at a concentration which results in a density for the composition of at least 1.5. In a preferred embodiment the inorganic filler is a powder having a particle size not exceeding 150 microns and in yet another preferred embodiment the inorganic filler is barium sulfate.

In another preferred embodiment the composition is extruded and laminated on the rear surface of a carpet, and in a particularly preferred embodiment the composition is at least 0.5mm thick.

DETAILED DESCRIPTION

This invention may specifically be constructed in various forms including:

(1) a sound insulating needle punched carpet comprising the composition having a density

of at least 1.5 and a flexural modulus not exceeding 5,000 kg/cm², and bonded to the rear surface of a carpet obtained by needle punching the fibers on a primary cloth such as of jute, synthetic fibers and flat yarn; (2) a sound insulating looped-pile carpet comprising the composition having a density of at least 1.5 and a flexural modulus not exceeding 5,000 kg/cm², and bonded to the rear surface of a carpet obtained by implanting looped piles on a primary cloth such as of jute, synthetic fibers and flat yarn; (3) a carpet similar to that described in (2), but having cut piles thereon.

For the purpose of this invention, the carpet may be a known carpet, such as one obtained by implanting looped or cut piles on the front surface of a primary cloth composed mainly of jute, synthetic fibers, flat yarn, or the like, and a needle punched carpet.

The composition for use according to this invention, comprising a polyolefin, synthetic rubber, petroleum oil and an inorganic filler, and having a density of at least 1.5 and a flexural modulus not exceeding 5,000 kg/cm² may contain 5 to 400 parts by weight of the synthetic rubber for 100 parts by weight of the polyolefin, 5 to 100 parts of the petroleum oil for a total of 100 parts by weight of the polyolefin and the synthetic rubber, and that quantity of the inorganic filler which is required to enable the composition to have a density of at least 1.5 and a flexural modulus not exceeding 5,000 kg/cm².

The polyolefin may be an α-olefin homopolymer, or a crystalline copolymer consisting mainly thereof, such as polyethylene, polypropylene, polybutene-1, poly-4-methylpentene-1, an ethylene-propylene copolymer, e.g., ethylene-propylene block copolymer, an ethylene-butene-1 copolymer, a propylene-butene-1 copolymer, an ethylene-vinyl acetate copolymer, and ethylene-ethylacrylate copolymer. Polypropylene and an ethylene-propylene block copolymer are particularly preferable. It is possible to use either only one such polyolefin, or a mixture of two or more polyolefins.

The synthetic rubber may be an ethylene-α-olefin copolymer, a terpolymer or other copolymer comprising ethylene, an α-olefin and one or more dienes, or a copolymer of a monovinyl aromatic hydrocarbon and a conjugated diolefin. It may have an ethylene content of 20 to 80% by weight, a diene content of 5 to 40% by weight, a monovinyl aromatic hydrocarbon content of 20 to 80% by weight, and a Mooney viscosity (ML_{1+4} at 100°C) of 10 to 150. Examples of such rubber include ethylene-propylene rubber, an ethylene-butene-1 copolymer, an ethylene-propylene-ethylidenenorbornene terpolymer, an ethylene-propylene-dicyclopentadiene terpolymer, an ethylene-propylene-1,4-hexadiene terpolymer, a styrene-butadiene block copolymer, and a styrene-butadiene random copolymer. Ethylene-propylene rubber is particularly preferable.

The petroleum oil may be a hydrocarbon having a boiling point of at least 350°C, for example, a paraffinic, naphthenic or aromatic high-boiling petroleum fraction. A paraffinic fraction is particularly preferable. These oils include process oil.

The inorganic filler may be selected from among metals, metal compounds, silicates and silicate minerals, and those which are chemically stable in ordinary use. More specifically, the inorganic filler may, for example, be a metal such as iron, zinc, nickel, chromium, lead, copper, molybdenum and manganese, an oxide, carbonate or sulfate of any such metal, or barium, aluminum, titanium, calcium or magnesium, or talc, clay, silica, mica, asbestos, silicic anhydride, or the like. It is particularly preferable to use calcium carbonate, barium sulfate, lead, iron, zinc, or a compound of any such metal. Barium sulfate is most preferable from the standpoint of thermal stability. It is possible to use either only a single kind of filler, or a mixture of two or more. The filler may be composed of a powder, fibers, foils, or the like, but it is desirable to use a powder having a particle size not exceeding 150 μ (microns) based on workability. The quantity of the filler to be incorporated depends on its specific gravity. If a filler having a specific gravity of 2 is used, it is necessary to incorporate at least 260 parts by weight of the filler for 100 parts by weight of a polymer composition, i.e., a combination of the polyolefin, the synthetic rubber and the petroleum oil. Any smaller amount than that results in a sheet having a specific gravity of 1.5 or below, and which is not expected to be satisfactory in sound insulation. The upper limit to the quantity of the filler which can be incorporated may be increased to the maximum quantity that is generally proportional to the density of the powder if the powder has a particle size of 150 μ or below. If the workability and flexibility of the composition when molded are taken into consideration, however, it is advisable not to incorporate more than twice as much of the filler as the polymer composition by real volume ratio It is, thus, effective to incorporate within the aforesaid range a lot of a filler having the highest possible specific gravity in order to obtain a composition having a sufficiently high density to provide a satisfactory sound insulating effect, and yet high workability and flexibility.

There is no limitation in particular to the method for bonding to a carpet a composition having a density of at least 1.5 and a flexural modulus not exceeding 5,000 kg/cm², but it is possible to employ a customary method, such as extrusion lamination and the application of an adhesive. It is, however, industrially appropriate to melt the polymer composition by heat, extrude it continuously through a nozzle on an extruder for lamination on the rear surface of a carpet, and apply a pressure thereto by a roller. The amount of the composition to be laminated depends on

the purpose for which the carpet is used, but generally, as a greater thickness produces a high effect of sound insulation, it is desirable to laminate the composition in a thickness of at least 0.5 mm, and particularly at least 0.8 mm (i.e., to the extent that the carpet may have a surface density of at least 2 kg/cm^2). If required, it is possible to incorporate a coloring agent, an antistatic agent, an antioxidant, a lubricant, an ultraviolet liquid absorber, a heat stabilizer, a surface active agent, or the like into the composition.

As hereinabove described, this invention provides a carpet which is superior in sound insulation and flexibility, and is not only suitable for use with automobiles, but also with other vehicles and buildings.

The invention will now be described with reference to examples which are not intended to be limiting. All parts are shown by weight in the examples.

Example 1

(1) Preparation of the composition to be bonded to a carpet.

Various compositions were prepared by charging various proportions, as shown in TABLE 1, of polypropylene (PP) having a MI of 22 at 230°C according to ASTM D-1238, an ethylene-vinyl acetate copolymer (EVA) having a MI of 20 at 190°C, ethylene-propylene rubber having an ethylene content of 70% by weight and a Mooney viscosity of 70, barium sulfate ($BaSO_4$) having an average particle size of 7 μ and a paraffinic process oil (Kyodo Sekiyu's R-1000) into a Banbury mixer, and kneading them for 10 minutes at a temperature of 190°C to 200°C, followed by cooling and crushing. Each of the compositions thus obtained was tested for density according to JIS K-6758, for flexural modulus according to ASTM D-790, for melting point by a DSC differential calorimeter, and for flexibility. The results are shown in TABLE 1. The flexibility of each composition was evaluated by a bend and feel test on a sheet thereof having a thickness of 3 mm. In TABLE 1, a double circle means 'very soft'; a single circle, 'soft'; and an x, 'hard'.

(2) Manufacture of sound insulating carpets.

Each of the compositions obtained from Run Nos. 1 and 2 was continuously extruded through an extrusion molding machine, and laminated in a thickness of 2.5 mm on the rear surface of a needle punched carpet obtained by needle punching polypropylene fibers (15 d) (800 g/m^2) and backing with a latex, followed by compression, whereby a carpet was formed.

The carpets of this invention obtained as hereinabove described were compared with known automobile carpets obtained by extrusion laminating low-density polyethylene having a MI of 5 and a density of 0.912 on carpet bases of the same type as used for preparing the carpets of this invention. The carpets were mounted for covering the floor of an automobile, and compared with respect to the noise heard within the automobile when it was running. The results are shown in TABLE 1.

TABLE 1

Properties of compositions for bonding to carpets

Run No.	PP	EVA	EPR	$BaSO_4$	Process oil
1	10	—	10	65	15
2	15	—	10	65	10
3 (Comparative Example	35	—	—	65	—
4 (Comparative Example	—	35	—	65	—
Comparative Example	—	—	—	—	—

TABLE 1 (Continued)
Properties of compositions for bonding to carpets

Run No.	Density (g/cm^3)	Flexural modulus (Kg/cm^2)	Melting point (°C)	Flexibility	Carpet evaluation: Surface density (Kg/cm^2)	Carpet evaluation: Noise* inside automobile (dB)
1	1.86	2,000	151.8	◎	5.45	65
2	1.87	2,500	153.2	○	5.48	65
3 (Comparative Example)	1.88	22,000	161.5	×	—	—
4 (Comparative Example	1.89	5,000	65.0	○	—	—
Comparative Example	—	—	—	—	3.08	74

(Note)* The noise was measured with an automobile running at 100 km/hr. in a chassis testing apparatus.

Example 2

Compositions and carpets were prepared and tested by repeating the procedures of Example 1, except for the use of the polyolefin, synthetic rubber, petroleum oil, inorganic filler and carpet which will hereunder be listed. The results are shown in TABLE 2.

(1) Polyolefin

(A) Ethylene-propylene block copolymer having an ethylene content of 7% by weight and a MI of 9 at 230°C.

(2) Synthetic rubber

(B_1) Styrene-butadiene block copolymer having a styrene content of 40% by weight and a Mooney viscosity of 24;

(B_2) Ethylene-propylene rubber having an ethylene content of 70% by weight and a Mooney viscosity of 70; or

(B_3) Ethylene-propylene-ethylidenenorbornene terpolymer having a propylene content of 40% by weight, an ethylidenenorbornene content of 15% by weight and a Mooney viscosity of 105.

(3) Petroleum oil

(C_1) Paraffinic process oil; or

(C_2) Napthenic process oil.

(4) Inorganic filler

(D_1) Zinc oxide having an average particle size not greater than 1 μ;

(D_2) Calcium carbonate having an average particle size of 2 μ;

(D_3) Talc having an average particle size of 12 μ;

(D_4) Iron powder having an average particle size of 90 μ; or

(D_5) Iron oxide having an average particle size of 1 μ.

(5) Carpet

Needle punched carpet (15 d polypropylene fibers; 800 g/m^2).

TABLE 2 Properties of compositions for bonding to carpets

Run No.	Polyolefin (parts)	Synthetic rubber (parts)	Petroleum oil (parts)	Inorganic filler (parts)
5	A (30)	B_1 (10)	C_2 (10)	D_1 (100)
6	A (20)	B_1 (10)	C_2 (20)	D_1 (100)
7	A (10)	B_2 (5)	C_1 (10)	D_2 (75)
8	A (10)	B_2 (5)	C_1 (10)	D_3 (75)
9	A (20)	B_3 (10)	C_1 (10)	D_4 (120)
10	A (20)	B_3 (10)	C_1 (10)	D_5 (120)
Comparative	—	—	—	—

TABLE 2 (Continued) Properties of compositions of bonding to carpets

Run No.	Density (g/cm^3)	Flexural modulus (Kg/cm^2)	Melting Point (C°)	Flexibility	Carpet evaluation: Surface density (Kg/cm^2)	Carpet evaluation: Noise inside an automobile (dB)
5	2.03	2,000	154.1	○	5.88	64
6	2.02	1,500	152.9	◎	5.85	64
7	1.79	3,800	156.3	○	5.28	65
8	1.68	4,500	158.4	○	5.00	66
9	2.66	2,500	155.5	○	7.45	62
10	2.33	2.200	154.8	○	6.62	63
Comparative	—	—	—	—	3.08	74

Reference Example

TABLE 3 shows the sound insulating characteristics measured on the carpets prepared in Runs Nos. 2 and 9 and the Comparative Example shown in TABLE 1. For determination of the sound insulating effect of each carpet, it was mounted on a speaker box in which the vibration generated by a transmitter was converted to a noise by a loud speaker. The noise arising from the loud speaker was received by a microphone in a noise meter positioned opposite to the speaker, and the sound pressure was measured at various frequencies.

TABLE 3

Run No.	Filler	Surface density (Kg/cm^2)
2	$BaSO_4$	5.48
9	Iron powder	7.45
comparative Example	—	3.08

TABLE 3 (Continued)

Run No.	Transmission loss (dB) [Needle punched carpet having a 25 mm thick sheet laminated thereon] Frequency for measurement (Hz)					
	100	200	400800	1,000	2,000	4,000
2	17	14	16 25	25	33	38
9	15	12	18 27	28	36	41
comparative Example	<5	<5	10 15	16	23	29

CLAIMS

1. A sound insulating carpet construction comprising a carpet having a rear surface, and a composition bonded to said rear surface, said composition comprising (A) polyolefin, (B) ethylene-α-olefin or monovinyl aromatic hydrocarbon conjugated diolefin copolymer rubber, (C) petroleum oil and (D) inorganic filler.

2. A carpet construction according to claim 1 wherein said carpet is selected from needle punched carpet, looped pile carpet and cut pile carpet.

3. A carpet construction according to claim 1 or 2 wherein said rear surface is comprised of a primary cloth selected from jute, synthetic fibers and flat yarn.

4. A carpet construction according to claims 1–3 wherein said composition has a density of at least 1.5.

5. A carpet construction according to claims 1–4 wherein said composition has a flexural modulus not exceeding 5,000 kg/cm^2.

6. A carpet construction according to claims 1–5 wherein said polyolefin is polypropylene or ethylene-propylene block copolymer.

7. A carpet construction according to claims 1–6 wherein said ethylene-α-olefin rubber is selected from the group consisting of ethylene-propylene copolymer, ethylene-propylene-ethylidenenorbornene terpolymer, ethylene-propylene-dicyclopentadiene terpolymer and ethylene-propylene-1,4-hexadiene terpolymer.

8. A carpet construction according to claims 1–7 wherein said petroleum oil is selected from paraffinic, naphthenic and aromatic process oils.

9. A carpet construction according to claims 1–8, wherein said inorganic filler is selected from the group consisting of calcium carbonate, barium sulfate, and the oxide carbonate and sulfate of lead, iron and zinc.

10. A carpet construction according to claim 9 wherein said inorganic filler is a powder having a particle size not exceeding 150 microns.

11. A carpet construction according to claim 10 wherein the ratio of the volume of said inorganic filler to the sum of the volumes of components (A), (B) and (C) is less than or equal to two.

12. A carpet construction according to claims 1–11 wherein the thickness of said composition bonded to said rear surface is at least 0.5 mm.

13. A method for producing a sound insulating carpet construction according to claims 1–12 comprising provided a primary cloth having a rear surface and a front surface, preparing a sound insulating composition comprising (A) polyolefin, (B) ethylene-α-olefin or monovinyl aromatic hydrocarbon-conjugated diolefin copolymer rubber, (C) petroleum oil and (D) inorganic filler, implanting carpet fibers in said front surface and bonding said composition to said rear surface.

14. A method according to claim 13 wherein said composition is melted by the application of heat, extruded and laminated to said rear surface by the application of pressure.

15. A method according to claim 13 or 14 wherein the thickness of said composition on said rear surface is at least 0.5 mm.

16. A method according to claims 13–15 including molding said carpet construction into a desired shape by the application of heat and pressure thereto.

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